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FAST ALGORITHMS FOR THE CMU ATTACHED PROCESSOR SYSTEM

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(U) CARNEGIE-MELLON UNIV PITTSBURGH PA DEPT OF  
MATHEMATICS H D GUNZBURGER 1986 AFOSR-TR-87-0897

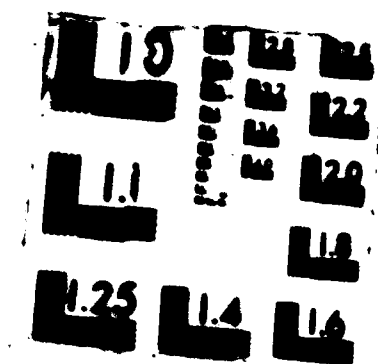
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Max D. Cumberger

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## 19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This project concerned research on developing fast algorithms for implementation on a parallel processing system. Titles of research papers resulting from this effort include the following: Least squares methods for fourth order problems, Least squares methods for problems with corner singularities, Finite element methods for the streamfunction-vorticity equations, and On substructuring algorithms and solution techniques for the numerical solution of partial differential equations.

## 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT

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**Final Report for Air Force Office of Scientific  
Research Grant AFOSR 85-0277  
Fast Algorithms for the CMU Attached Processor System**

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We report on work performed with support of Air Force Office of Scientific Research Grant AFOSR 85-0277. We begin by listing the personnel which received some support from the grant:

George Fix - Professor of Mathematics;  
Max Gunzburger - Professor of Mathematics;  
R. A. Nicolaides - Professor of Mathematics;  
William Layton - Visiting Associate Professor;  
Bengi Guo - Post-doctorate Fellow; and  
Maria Cayco - Post-doctorate Fellow.

We discuss research accomplishments by listing papers prepared under grant sponsorship and briefly describing their content. Preprints of these papers are being forwarded, under separate cover, to the contract monitor, Captain John Thomas.

**Least squares methods for fourth order problems** - G. Fix and E. Stephan - To appear in *Archive for Rational Mechanics* - The least squares finite element method has been shown to be useful for the approximate solution of second order elliptic partial

differential equations. In this work, the method is extended to fourth order elliptic problems. In particular, finite element algorithms are given which are optimally accurate and which do not suffer from the usual problems associated with the approximation of fourth order problems, e.g., do not require the use of high continuity finite element spaces

**Least squares methods for problems with corner singularities** - C. Cox and G. Fix - To appear in *Computers and Mathematics with Applications* - Typically, when the exact solution of boundary value problems for elliptic partial differential equations are singular due to the presence of corners in the boundary of the domain, least squares finite element methods do not achieve the same accuracy as do analagous methods applied to problems with smooth solutions. It is shown that through the use of appropriate weights in the least squares functional and appropriate mesh refinement techniques, that the optimal accuracy can be recovered. Such algorithms have been implemented in computer codes and extensive numerical experiments, as well as mathematical analyses have been carried out.

**Finite element methods for the streamfunction-vorticity equations** - G. Fix - To appear in the *Proceedings of the Conference on Numerical Methods for Water Resource Problems* - Existing theories for finite element methods for the streamfunction vorticity equations predict rates of convergence which are lower than those observed in practice. This includes the widely used case of methods which use continuous piecewise linear finite element spaces for both the streamfunction and vorticity. It is shown, through the use of novel mathematical techniques, that the finite element approximation of the derivatives of the streamfunction, and hence the velocity field, converges at an optimal rate. Improved error estimate for the vorticity approximation are also obtained.

**On substructuring algorithms and solution techniques for the numerical solution of partial differential equations** - M. Gunzburger and R. Nicolaides - To appear in *Applied Numerical Methods* - Substructuring techniques, which contain large amounts of inherent parallelism, have long been popular methods of discretization and solution for positive definite problems in,



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